What is claimed is:

1. An infrared absorption spectrometer, comprising:

A. a substrate;

B. an optical waveguide having an input end and an output end, said waveguide being adapted for transmitting optical radiation incident on said input end to said output end; and

C. at least one optical microcavity constructed and arranged so as to optically interact with light incident on said input end of said optical waveguide core, so that light from said waveguide core is coupled into said microcavity;

wherein light coupled into said optical microcavity is adapted to interact with at least one of an atomic and a molecular species; and

wherein said optical microcavity is configured so that the frequency of at least one resonant mode of said optical cavity matches a vibrational frequency of said at least one of an atomic and a molecular species, so that optical radiation coupled into said optical microcavity and having a frequency substantially equal to said frequency of said at least one resonant mode is absorbed by said at least one of an atomic and a molecular species.

2. An infrared absorption spectrometer according to claim 1, wherein said optical microcavity is disposed at a distance from said optical waveguide that is sufficiently

small to cause the evanescent field of said optical radiation propagating through said optical waveguide to be optically coupled into said microcavity.

3. An infrared absorption spectrometer according to claim 2, wherein said evanescent field is characterized by frequencies substantially equal to a resonant modes of said optical microcavity.

4. An infrared absorption spectrometer according to claim 3, wherein at least one of said resonant modes of said optical microcavity is a whispering gallery mode.

5. An infrared absorption spectrometer according to claim 4, wherein said optical microcavity has a substantially spherical shape, and wherein the wavelengths of the whispering gallery modes of said microcavity are related to the radius r and the degree of sphericity of said substantially spherical microcavity, and are approximately given by the formula:

$$2 \pi r = n\lambda,$$

where n is a nonzero integer.

6. An infrared absorption spectrometer according to claim 1, wherein said optical waveguide comprises:

a splitter for splitting said input optical radiation into a first signal and a second signal;

a first waveguide branch and a second waveguide branch for transmitting said first signal and said second signal, respectively; and

a combiner for recombining said first signal and said second signal.

7. An infrared absorption spectrometer according to claim 1, wherein said optical waveguide includes channels arranged in a Mach-Zehnder interferometer configuration.

8. An infrared absorption spectrometer according to claim 1, wherein said optical waveguide core includes a drop channel, a throughput channel, and a reference channel, arranged so that the optical microcavity can optically interact with both the drop channel and the throughput channel, but does not substantially optically interact with light in the reference channel.

9. An infrared absorption spectrometer according to claim 1, wherein said optical microcavity is selected from the group consisting of microspheres, microdisks, and microrings.

10. An infrared absorption spectrometer according to claim 1, further comprising a light source arranged to input light into said input end of said optical waveguide.

11. An infrared absorption spectrometer according to claim 1, further comprising at least one detector constructed and arranged so as to detect output optical radiation from said output end of said optical waveguide.

12. An infrared absorption spectrometer according to claim 1, wherein said optical microcavity is made of silica.

13. An infrared absorption spectrometer according to claim 1, wherein said optical waveguide is an integrated optical chip.

14. An infrared absorption spectrometer according to claim 1, wherein the coupling efficiency of said evanescent field of said optical radiation coupled into said optical microcavity is from about 10% to about 98%.

15. An optical resonator according to claim 1, wherein said optical microcavity is fabricated by melting one end of an optical fiber.

16. An optical resonator according to claim 1, wherein said optical microcavity is characterized by a quality factor (Q) from about 10^5 to about 10^{10}.

17. An optical resonator according to claim 1, wherein said optical microcavity is characterized by a diameter of about 50 μm to about 500 μm.

18. An optical resonator according to claim 1, wherein said optical microcavity is characterized by a diameter of about 200 μm.

19. An optical resonator according to claim 2, wherein said distance is less than one wavelength of said optical radiation propagating through said optical waveguide.

20. An optical resonator sensor according to claim 1, wherein said optical waveguide comprises:

(a) a multi-layer dielectric stack disposed on said substrate, said dielectric stack including alternating high and low refractive index dielectric layers; and

(b) a waveguide core disposed on said dielectric stack and having an input end and an output end, said waveguide core being adapted for transmitting optical radiation incident on said input end to said output end.

21. An optical resonator sensor according to claim 20, wherein one of said low refractive index layers is in contact with said substrate, and wherein one of said high refractive index layers is in contact with said waveguide core.

22. An optical resonator sensor according to claim 20, wherein said low index dielectric layer and said waveguide core comprises silica.

23. An optical resonator sensor according to claim 20, wherein said high index dielectric layer comprises silicon.